TERRATHERM BACK GROUND

Facts about In Situ Thermal Desorption
From TerraTherm Environmental Services Inc.

It is estimated that there are tens of thousands of sites across the country in need of remediation. Finding a way to clean them up in a safe, cost-effective and environmentally responsible way is a challenge. Now, a new technology is revolutionizing the remediation of contaminated sites – *In Situ Thermal Desorption.*

WHAT IS IN SITU THERMAL DESORPTION?

In Situ Thermal Desorption is a novel remediation process offering a cost-effective solution to difficult cleanup problems. It remediates a variety of organic contaminants without having to excavate the soil. The process is safe, low profile, virtually dust- and odor-free. There are currently two forms of the technology: Thermal Blankets and Thermal Wells.

WHAT ARE THERMAL BLANKETS?

The Thermal Blanket works like a large electric blanket and a powerful vacuum cleaner. Shell's simulations suggest that the Thermal Blanket, used for surficial contamination, works to a depth of approximately three feet.

Typically, each Blanket is made up of an 8' by 20' steel box. Suspended from the bottom of the box is a layer of stainless steel webbing, which looks like chain link fence. Heating element rods are threaded through the webbing to transfer heat into the soil below the Blanket. A 12" layer of insulation fills the box to conserve heat. An empty space is left between the insulation and the webbing to allow for vapor collection. Several Blankets set up side-by-side increases the total area treated at one time.

Contaminants are vaporized by heating the soil with the Blanket. Contaminated vapors are then drawn out of the soil and through the Blanket by a vacuum system. Most contaminants are destroyed in the extremely hot soil near the heat source. Remaining vapors are cleaned in a trailer-mounted Vapor Treatment System, emitting only carbon dioxide and water vapor into the atmosphere.

WHAT ARE THERMAL WELLS?

Thermal Wells use the same scientific process as Thermal Blankets, except that heating elements are placed in wellbores drilled on a regular pattern. Typical Well spacings can be seven to ten feet. As the heat from Thermal Wells vaporizes soil contaminants, a vacuum applied to each well draws the contaminants out of the ground.

Wells can be drilled vertically to the contaminated zone, possibly as deep as several hundred feet. They may reach horizontally under operating facilities, roadways and through concrete and other structures. Simulations suggest that Thermal Wells can work both above and below the

water table. Treatment of the saturated zone can be achieved if the site is managed to dewater the treatment zone and to limit recharge rates. The technology is currently being field tested and should be commercially available in 1997.

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WHAT ARE THE BENEFITS OF TERRATHERM'S IN SITU THERMAL DESORPTION?

TerraTherm's In Situ Thermal Desorption technology has all the safety and environmental advantages of in situ remediation processes. It eliminates excavation and hauling, it is dust- and odor free, provides quiet, low profile operations with minimal neighborhood disruptions; and has no long-term disposal liability in landfills. In addition, TerraTherm's technology provides benefits not found in conventional remediation techniques:

- In situ remediation of a mix of volatile and semi-volatile organic compounds
- Cleans to very low residual levels
- Works in heterogeneous soils including low-permeability clays
- Potential to work in both unsaturated and saturated zones
- Cost-effective solution for difficult cleanup problems
- Used for surficial and deeper contaminated zones
- Can be used without shutting down normal operations
- Mostly CO2 and H2O released to the atmosphere
- Fastest in situ remediation
- Enhanced project design via site-specific simulations of the process

HOW DOES THE THERMAL BLANKET SYSTEM WORK?

In the Thermal Blanket process, the Blankets are first placed over the contaminated area. A silicone rubber vapor barrier is laid over the Blankets and sealed around the perimeter. The suction port from each Blanket is connected to the piping manifold, which feeds to the Vapor Treatment System.

When the Blankets are in place, the trailer-mounted Vapor Treatment System draws a vacuum under the Blankets using a main and backup blower. This sucks vapors up through the soil.

The thermal oxidizer on the Vapor Treatment System is a flameless design with 99.99% destructive efficiency. Any volatile contaminants drawn out of the cool soil in this early stage are either oxidized in the thermal oxidizer or adsorbed on the activated carbon adsorber.

The next step involves heating the soil to remove the contaminants. As the Blanket temperature rises to a target of 800°-1,000°C, heat from the Blanket is transferred into the ground by thermal conduction.

Because of soil moisture, the temperature rises first to 100°C and stabilizes temporarily until all of the moisture is boiled off. During that time, volatile contaminants are removed by evaporation and steam distillation. In this early stage of heating, some organic contaminants may reach the soil surface intact but are still destroyed in the thermal oxidizer.

Once the soil is dried, the temperature rises above 100°C until it reaches a predetermined target temperature set according to the boiling point of the contaminants being treated. During this treatment period, even low volatility organic compounds are vaporized and drawn upward through the soil into the Thermal Blanket and Vapor Treatment System.

As they move upwards, the contaminated vapors pass through successively hotter layers of soil, where many are destroyed thermally on the hot surfaces of the soil granules. Residual organics that are not oxidized in the soil are remediated in the flameless thermal oxidizer or adsorbed on the activated carbon, leaving virtually only carbon dioxide and water in the air emissions.

The final step involves cooling down the Thermal Blankets while maintaining suction. Once the ground surface has cooled, the Blankets can then be safely dismantled and moved to treat another area. The remediated area is now ready for revegetation.

Thermocouples at various ground depths are used to closely monitor the temperature throughout the process from the on-site Control Trailer. Soil samples are taken pre- and post-treatment. Actual results from temperature monitoring and soil sampling at test sites agree with TerraTherm's numerical simulations.

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HOW DO THERMAL WELLS WORK?

As mentioned earlier, the Thermal Wells use the same In Situ Thermal Desorption process as the Thermal Blankets. Heating elements are placed in vacuum suction Wells drilled on a regular pattern. The same Vapor Treatment System is used for both Thermal Wells and Thermal Blankets.

HOW LONG DOES IN SITU THERMAL DESORPTION TAKE?

Treatment periods depend on a number of factors such as depth of contamination, soil moisture, contaminant types, and soil types. In general, Thermal Blanket treatments require as little as a few days of operation per placement. (The present commercial system can treat 3,200 square feet per placement.) In the case of Thermal Wells, the Wells are first drilled over the entire area to be remediated. Once energized, the remediation will take one to two months.

HOW DO YOU KNOW WHEN CLEANUP IS COMPLETE?

First, remediation levels and cleanup times can be predicted by computer simulation before the job starts. After that, monitoring systems and thermocouple probes in the soil are used to measure the progress of the thermal front through the soil. Experience has shown that there is good agreement between the computer predictions and actual results. Pre- and post-treatment samples are used to verify the treatment.

WHAT ABOUT AIR EMISSIONS USING THIS TECHNOLOGY?

TerraTherm's In Situ Thermal Desorption system is designed to prevent the release of contaminants. At the surface, the collected vapors are sent through a flameless thermal oxidizer and an activated carbon adsorber to ensure that virtually all vaporized contaminants are either oxidized or adsorbed. Contaminant emissions in field tests for a nationwide TSCA permit were quite low– exceeding 99.9999% (6 "nines") destruction efficiency for PCBs, and the principal substances released to the atmosphere were carbon dioxide and water.

WHAT IF THE SYSTEM LEAKS?

The last process step in the Vapor Treatment System involves a main and backup vacuum blower system that draws vapors through the rest of the unit. Thus, the entire system operates at sub-atmospheric pressures, and any leakage would be from the outside into the system.

DOES THIS PROCESS CREATE DUST?

With In Situ Thermal Desorption, there is no excavating or hauling, no earth moving or soil transport, therefore, virtually no dust is created.

WHAT POLLUTANTS CAN BE TREATED THIS WAY?

In Situ Thermal Desorption technology can be used to remediate a wide variety of volatile and semi-volatile organic contaminants including:

- PCBs
- Chlorinated solvents
- Pesticides
- Petroleum wastes

Field demonstrations are planned for using the technology to remove and collect low boiling point metals, such as mercury, from soil. TerraTherm's technology can be used in a variety of soils including low permeability clays and heterogeneous soil compositions.

WHAT REMEDIATION LEVELS CAN BE ACHIEVED?

At an upstate New York site contaminated with PCB levels as high as 5,000 ppm, PCB residuals after treatment were less than 2 ppm, significantly lower than New York State and federal cleanup requirements.

WHAT HAPPENS TO HALOGENS FROM PCBs AND SIMILAR MATERIALS?

When PCBs and other halogenated hydrocarbons are remediated, acids like HCl are produced. At the higher soil temperatures, these acids are rapidly stabilized by precipitation with natural soil elements, principally carbonates and iron. The resulting chlorides are harmless and very stable. Experience remediating PCBs shows that acid gas emissions typically are very low.

IS THE SOIL ALTERED BY THIS PROCESS?

No. Except for soil dewatering, the operating temperature is not high enough to affect the structural integrity of the soil materials.

DOES THIS PROCESS PREVENT REVEGETATION AFTER TREATMENT IS COMPLETE?

No. Immediately after treatment by In Situ Thermal Desorption, the soil is sterile. But experience shows that recovery will be rapid. If the soil is disked, fertilized and seeded following normal revegetation practices, regrowth during the first growing

season after treatment should be as good as with any other soil. One example in upstate New York even showed that weeds, moss and other vegetation can naturally cover a treated area within one growing season without any fertilization or other intervention.

DOES SOIL PERMEABILITY AFFECT REMEDIATION PERFORMANCE?

In Situ Thermal Desorption has been found to operate very well on most high- and low-permeability soils. Compared with liquid movement, vaporized contaminants move easily through tighter soils, and the path of least resistance is always towards the low-pressure zone created by the vapor collection system.

DOES SOIL MOISTURE AFFECT PERFORMANCE?

High soil moisture does not necessarily preclude the use of these technologies. However, the energy cost to complete remediation rises with the amount of water that must be vaporized during treatment. Pilot tests are typically conducted during the design phase for any project to confirm that In Situ Thermal Desorption will be effective at each site and to confirm cost assumptions.

With aquifer controls to limit recharge rates from areas upgradient and site management to dewater locations if necessary, In Situ Thermal Desorption can be used to treat saturated as well as unsaturated sites.

HOW DEEP IS THIS TECHNOLOGY EFFECTIVE?

TerraTherm's simulations suggest that Thermal Blankets are effective to a depth of approximately three feet. Thermal Wells may be drilled vertically to depths of several hundred feet and extended horizontally to reach contaminated areas previously thought untreatable.

WHERE HAS THIS SYSTEM BEEN USED?

The Thermal Blanket has been used on the Gulf Coast, in Colorado and in upstate New York. Testing of the Thermal Wells got under way in late 1996.

IS REGULATORY APPROVAL NEEDED BEFORE IN SITU THERMAL DESORPTION IS USED?

As with any remediation project, some level of both state and federal approval is required. However, since the flameless thermal oxidizer is classified as an "other" air emissions control device, air permits typically can be obtained in a relatively short time. State approvals under Voluntary Cleanup Initiatives can usually be obtained as quickly.

HOW MUCH DOES IT COST?

This depends on a variety of factors such as depth of contamination, soil moisture, and contaminant types. In general, In Situ Thermal Desorption is cost-competitive for TSCA and RCRA wastes with alternative processes, since excavation, hauling, backfilling and off site disposal or incineration are not required. Also, in many industrial and utility applications, remediation can usually be completed with minimal disruption to ongoing operations, reducing the overall cost impact. A low cost pilot test using TerraTherm's Mobile Demonstration Unit can be performed on site. This can provide process efficiency and cost estimates.

HOW DO I GET THIS SERVICE?

Shell Technology Ventures Inc. has created TerraTherm Environmental Services Inc., to provide Thermal Blanket and Thermal Well services. You can reach them at the address and telephone numbers below.

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12/96 Printed on recycled paper.